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INSTRUCTIONS FOR THE FLS AEROMOTOR

F.L. Smidth & Co.

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16. Abstract This report is a comprehensive study of the complete system necessary for the conversion of wind power to electrical power. Complete descriptions of the propellor, gear system, dynamo, starter propeller, and braking mechanism are given, as they relate to the system manufactured by F.L. Smidth & Co. of Denmark. Complete instructions for the operation and maintenance of the system are given. The safety systems and an overall view of the system's operation are also given. Diagrams showing the entire system in detail are included.

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INSTRUCTIONS FOR THE FLS AEROMOTOR

F.L. Smidth & Co.

I. Description /1*

A. General

The FLS Aeromotor consists of the following main parts:

three-bladed propeller made of wood and equipped with de-energizing rails and spring governors.

precision gears, ratio 1:24.7

70 kW, 500 V dynamo, 700-1400 rpm, counter compounded

starting propeller with relay.

brake.

The above-mentioned parts are mounted on a base frame and form the Aeromotor's top unit (see p. 18).

The top unit is mounted on a tower which is 24 m high. The connection between the tower and the top unit consists of a gear rim, upon which the base frame rests, so that it can rotate about the tower's axis.

Two six-bladed yawing blades hold the propeller up into the wind. Thus, the propeller is always rotated around into the wind, unless the wind suddenly changes direction or, from a state of

* Numbers in the margin indicate pagination in the foreign text.

calm, begins to increase from a direction diametrically opposite to the direction from which it came when it slackened off.

A set of contact rings, one portion of which is firmly coupled to the top unit, and the other portion of which is firmly coupled to the tower, establishes the electric connection with the cables on the top unit and the cables in the tower.

A lightning rod, which is connected to the gear rim with galvanized steel cable (12 mmØ) and trolley shoes, is mounted upon the top unit. From the gear rim a lightning rod, which is built into the tower, completes the connection with the ground electrode. All of the metal parts in the tower and top unit are connected to these same electrodes with galvanized steel cable. Thus, we employ both a lightning rod system and a protective ground wire system.

There is a room in the bottom of the tower in which we have mounted a windlass which is used to service the de-energizing system and the brake. The connection between the de-energizing system and the windlass is made by a pipe going up through the tower. Inside this pipe is found the wire which connects the brake and the windlass (see p. 21).

In addition, we refer to drawing No. 409042.

B. The Propeller /2

The propeller is constructed with a special type of wood glued together.

The propeller has been carefully worked to the proper streamlined form, and the wood is impregnated with a special lacquer.

The propeller is beveled so that it cannot be directly started by the wind. It must therefore be started electrically. The starting impulse comes from the start propeller (see p. 25).

C. De-energizing Unit and Brake

A rail for de-energizing is mounted upon each sail. Each rail is held in place by a governor spring, which is mounted in a spring box by the propeller axle and connected to the rail with a bracing wire. In neutral position, the rail is approximately parallel with the sail plane.

The field of regulation for the number of revolutions can be changed by changing the tension of the governor spring: but a change of this type should be made only by us.

The box for the governor springs can be rotated by the windlass in the tower in such a way that the de-energizing rails are set into operation. The propeller's rpm can be decreased by turning the windlass control clockwise. This is called de-energizing.

In order to stop the propeller completely, the brake weight is freed during the last portion of the windlass' motion, tightening the wire, and pulling the brake lock against the brake drum. By rotating the windlass the opposite direction (corresponding to a counterclockwise handle motion) the brake is first freed, and the de-energizing rails are afterwards pulled back to their neutral positioning (approximately parallel with the sail plane. This is called energizing.

A safeguarding system against wind from "behind" has been installed, in connection with the de-energizing windlass. By "wind from behind" we mean wind which comes in towards the backside of the propeller. If the propeller is revolving at the same time as wind is coming from behind, the propeller can be subjected to dangerous stresses, and the propeller must therefore be stopped. This is done with the help of a small motor mounted on the de-energizing windlass, which de-energizes and stops the Aeromotor whenever the start propeller rotates in the direction opposite to its starting direction.

D. Electrical Equipment

The principle for the electrical system is shown in diagram No. 410687, which corresponds to the circuit diagram No. 410686.

The dynamo is 70 kW and is magnetized, with the help of a counter compound winding, so that it will, with a grid tension of around 500 V, give a current which will correspond to the propeller's output at the wind strength (and rpm) in question. The dynamo can satisfy this condition in the area 700-1400 rpm. /3

The dynamo can also be used for battery recharging, in that it can function with tensions up to 600 V.

At the start of the Aeromotor the following relay in-couplings and out-couplings occur:

When the start propeller achieves a clockwise rpm (around 200 rpm) which corresponds to the wind strength at which the Aero-motor can generate power, the start relay's mercury switch in the start circuit is closed. At this point, the start contactor (F) is coupled in, connecting the dynamo's armature to the supply line through the start resistor (G). The start contactor will remain coupled in with the help of its holding contact, until the auxiliary tension relay (B) or the main contactor (K) is coupled in.

The same thing occurs when one presses the start button (Y) on the control board.

The start contactor's coil is led over a locking switch (Z) on the de-energizing windlass, so that the Aeromotor can only be started when it is fully energized.

A thermic maximum relay, which releases the start contactor if the start is of abnormally long duration, is mounted at the terminal for the armature circuit. After the maximum current has been relieved, this relay is readjusted by pressing a buttom which is mounted on the relay.

When the Aeromotor works itself up in rpm's, the armature voltage increases, and when this has reached around 450 V, the auxiliary voltage relay (B) is coupled in, at which point the voltage terminal on the difference voltage and the reverse current relay (C) is coupled in on the voltage difference above the main contactor (K). The relief switch is simultaneously connected to (B) which is placed in the coil circuit for the time relay (E). The contact at (B), which is placed in the coil circuit of the start contactor, is also broken.

When the propeller is running at around 25 rpm, the wind can pull the propeller around. If there is sufficient wind, the propeller will accelerate, and at an rpm corresponding to a dynamo tension of around 5 V above the line voltage (by this we mean the resistance voltage which the dynamo shall work on), the voltage coil on the relay (C) will attract the polarized armature, and the mercury contact will connect the voltage to the time relay (E), which couples in the auxiliary relay (D). At this point, the main contactor (K) is coupled in, without delay from the time relay (E). The dynamo is now coupled to the supply network and generating current. When the main contactor (K) is coupled in, the start contact (F) is coupled out (see above).

As long as the dynamo is generating current greater than 3-4 A, the current terminal at (C) will keep the mercury contact closed.

When the <u>propeller's rpm decreases</u>, the following occurs:

As soon as the current falls to 3-4 A, the current terminal is no longer capable of holding the mercury contact closed. This tilts over and opens the time relay (E) which later opens the auxiliary relay (D) of the time relay, after around 8 sec. This opens the auxiliary relay (D) for the current to the main contactor (K), which disengages and disconnects the dynamo from the supply network. If the dynamo voltage falls to around 400 V, then the auxiliary voltage relay (B) is coupled out, opening the /4
voltage coil at (C). This is necessary in order to protect the sensitive voltage coil at (C) against an overly large difference in voltage between the network and the dynamo.

The voltage limiter (J) can be adjusted to operate at a predetermined voltage with the help of the adjustment resistor (J_s). When the voltage in either the network or the battery to which the Aeromotor is connected climbs up to or above this predetermined value, the voltage limiter (J) is adjusted so that it will reduce the dynamo's magnetization and thereby reduce its output and attempt to limit the voltage to the predetermined value. The voltage limiter (J) does not function at voltages lower than the predetermined value.

The maximum contact breaker (N) is connected to the thermal maximum relays and the electromagnetic short circuit release.

In the case of higher rpm's, the idle counter compounded dynamo can reach high voltages, and in order to prevent the voltage from climbing to abnormally high values, the system is arranged so that, if a maximum switch falls, or a knife switch is pressed, then a resistance is inserted into the shunt circuit, reducing the voltage to a low value.

As an extra insurance against exceedingly high tensions, the overvoltage relay (A) is mounted in direct connection with the main cables from the dynamo. If the voltage exceeds around 550 V as a result of the dynamo being coupled from the network because of reasons other than those which are mentioned above (for example, fuse breakage), then this overtension relay will impart resistance to the dynamo shunt and, at the same time, disconnect the coils on the main contactor (K) and the start contactor (F).

When the start propeller rotates in the direction opposite to the direction in which it rotated at the start, because of wind from behind, the other mercury contact in the start relay is broken, and the backwind relay (L) is disconnected. When this relay loses its armature, current is connected to the pilot motor's contactor (T_I), and the pilot motor de-energizes and stops the Aeromotor. By using the double buttons marked "energizing" and "de-energizing" and the contactors (T_I and T_{II}), the Aeromotor can be energized or de-energized from the central exchange, or from the control board in the tower. The operation changeover switch (R) determines from which set of buttons the pilot motor will be controlled. The double buttons are mutually mechanically locked so that they do not simultaneously energize and de-energize, just as the electrical locking prevents an energizing which is simultaneous with de-energizing due to the backwind safeguarding unit. When the maximum contact breaker is released, the Aeromotor is de-energized and stopped, in that the voltage to the backwind relay's coil (L) is conducted over a biswitch on the maximum contact breaker.

II. Service and Operation /5

The designations in parentheses in the following refer to the indications on the diagrams.

Starting the Aeromotor

The two-pole maximum contact breaker (M) is coupled in, and the pilot current contact breaker (S) is closed. The operation changeover switch (R) is adjusted to "remote control," and we make sure that the operating handle on the de-energizing windlass is removed from the axle. The pilot current contact breaker (W) on the central exchange is closed, after which the button marked "energizing," which is mounted on the central exchange, is depressed, and the flow indicator is observed. The button is held down until the flow indicator's deflection has fallen to zero. Only then is the Aeromotor fully energized.

If there is sufficient wind, the Aeromotor will automatically begin to operate, and the ammeter on the pilot board at the central exchange shows deflection to the left. When the Aeromotor generates current, the ammeter exhibits deflection to the right. If we wish to read the dynamo voltage instead of the current, then the button marked "voltmeter," which is mounted on the pilot control board, is depressed, and the voltage is registered on the voltmeter (and the ammeter is simultaneous disconnected). By rotating the button, we are able to lock onto the desired position.

If the Aeromotor is to be started from the tower, for instance, during inspection, then the operating changeover switch (R) is adjusted to "local control," after which the button marked "energizing" is depressed until the Aeromotor is fully energized. When the tower is once again evacuated, the operating changeover switch (R) must once again be adjusted to "remote control."

Stopping the Aeromotor

The Aeromotor is de-energized and stopped by depressing the button marked "de-energizing," until the flow indicator's deflection has fallen to zero.

If the Aeromotor is to be stopped from the tower, then the operating changeover switch (R) must be adjusted to "local control."

If one desires to put the Aeromotor out of operation, the maximum contact breaker (N) and the pilot current contact breaker (S) are pulled.

Stopping the Aeromotor for Calm

No action is normally taken, and the Aeromotor will automatically begin to operate as soon as sufficient wind is once again present.

If one wishes to decide himself, at what time the Aeromotor is to resume operation, then the Aeromotor must be de-energized and stopped as described under "Stopping the Aeromotor."

The Start Contactor's Maximum Relay Release /6

If the start of the Aeromotor should be of abnormally great duration, it can happen that the maximum relay on the start contactor (F) is released. If a new start is to occur, the relay must be readjusted by depressing the button which is mounted on the start contactor.

Releasing the Maximum Contact Breaker

If the Aeromotor is overloaded, either by short circuiting of the supply network or by other causes, the maximum contact breaker (N) is released, and the Aeromotor is automatically de-energized and stopped simultaneously (with the help of the backwind relay (L)). Since some investigation is necessary in order to find the fault, the rules found under the point concerning maintenance and repairs should be observed.

When the cause of the overload is found and rectified, the Aeromotor is started as described under "Starting the Aeromotor."

Limitations of the Aeromotor's Output

The voltage limiter, if it is correctly adjusted, will normally take care of the limitation of the Aeromotor's output automatically, which should only be necessary occasionally.

Nevertheless, the Aeromotor's output can also be decreased by partially de-energizing the system, but this must only be done in exceptional cases. In such cases the output will decrease somewhat in relation to the wind strength. Partial de-energization of the Aeromotor is achieved by depressing the button marked "de-energizing" until the desired rpm and the desired output are achieved respectively. The pilot motor stops as soon as the button is released. If the output is to increase again, the Aeromotor is energized in the normal manner.

The Voltage Limiter

The voltage limiter (J) shall at all times be connected. At the voltage at which the Aeromotor normally functions (around 500 V), the voltage limiter should not be in operation, in other words, all of the contact pins should be submerged in the mercury, and the short circuit relay on the voltage limiter should be closed, so that the entire regulating resistance is short circuited. Only when the voltage achieves a value 20-25 V over the normal voltage (or more, if this can be allowed with respect to the consumers) should the regulator come into operation, in other words, the short circuit relay will disengage and more and more of the pins will be freed from the mercury, and thereby more and more of the regulating resistance will be added to the dynamo shunt circuit, so that the dynamo's magnetization is decreased. As a result of this, the output and the voltage will be limited.

The voltage limiter is adjusted with the help of the slide resistor (J_s), mounted on the pilot control board of the central exchange.

The short circuit relay is coupled in and out with the help of the mercury pipe, which is mounted on the voltage limiter's rocker arm, and the short circuit relay should be out as soon as the first contact pin comes free from the mercury. This can be achieved by changing the positioning of the mercury pipe with the help of the adjustment screw which is mounted on the holder.

Normally, the slide resistor (J_s) should not be moved, but only the positioning should be changed, if the normal value of the voltage at which the Aeromotor is to function is changed. /7

Protection Against Excessive Voltage and Voltage Imbalance

As was explained previously, an overvoltage relay (A) has been installed as a safeguard against failure of the relay system which would cause the dynamo to achieve an excessively high voltage. This overvoltage relay can, with the help of the changeover switch which is mounted on the relay, be adjusted so that it begins to function at around 450, 530, 570, and 650 V.

When the relay begins to function, resistance is imparted to the dynamo's shunt circuit, and the voltage is decreased to below 440 V. Simultaneously, the main contactor and the start contactor are relieved, so that neither of these can be coupled in.

Since the relay is equipped with two coils, one of which is connected between the zero and the positive leads, and the other between the zero and the negative leads, and each of them alone can release the contact system when the voltage in the polarity in question approaches one-half of the adjusted value, the relay will also provide protection against "imbalanced voltages," which can occur when, for example, the equalizer disengages.

When this relay has been released, it should be reset with the help of the handle which is mounted on the relay. The Aeromotor should be stopped beforehand and the error which has caused the release of the relay should be found and rectified. In order to stop the Aeromotor, it may be necessary to de-energize the system by operating the windlass by hand.

Shunt Regulator

No regulation of the shunt regulator (M) should normally be made, and it should remain in the position it was in when it was delivered from the factory.

Ground Electrodes for the Lightning Rod System

The total transition resistance for the electrodes in the ground should be as indicated in the power plant regulations, under the section on protective ground connections in electrical station rooms for low tension installations (for the time being, 2 ohms maximum). The ground electrodes may consist of grounding rods or band electrodes, arranged concentrically around the tower.

Conditions Which Shall be Observed During Maintenance and Repair

When the Aeromotor is not coupled to the central exchange, abnormally high voltages in the connecting leads, etc. can occur if there are problems in the relay system. The power installation up in the tower is completely tension free only when the Aeromotor is stopped, the contact breaker for the pilot current (W), mounted on the central exchange, is off and the maximum contact breaker (N), together with the pilot current contact breaker (S), both of which are mounted on the control board in the tower, are off.

In such a case, the control board can only be partially tension free, in that certain portions are directly under tension from the network.

One should be aware of the fact that the wiring, which is not /8
directly connected to the power installation, can be under tension.

N.B.

Whenever work is carried on on the wiring in the tower, the Aeromotor should be stopped, and the previously mentioned pilot current contact breakers (W) (on the central exchange) and (S) (in the tower), together with the maximum contact breaker (N) should be pulled. Furthermore, the operation changeover switch (R) should be turned to local control. (If, in the case of work being done on the pilot cables or other portions of the system, there is a danger that these systems can come under tension, then the safeguarding system mounted on the control panel for these cables should be removed before any investigation of the Aeromotor wiring is made.)

Operation Under Special Wind and Weather Conditions

Thunderstorms

Since the Aeromotor will normally be a very high point, and, because of the iron parts at the top, will be particularly vulnerable to lightning bolts, it should be stopped with one of the three blades pointing downwards, whenever thunderstorms prevail.

The Aeromotor is equipped with lightning rods, but in order to decrease the danger of overloading, caused by lightning bolts, spreading to the central exchange and the supply network, all of the contact breakers, which break the contact from the leads to the Aeromotor's tower, should be pulled. This applies to the contact breakers mentioned in the section "Maintenance and Repair."

Icing Up and Snow Weather

Whenever the blades are covered with ice, caution should be exercised whenever anyone ventures into the proximity of the Aeromotor, since snow and ice, adhering to the propeller, can be thrown off during the Aeromotor's start and operation.

During such weather conditions, one should also be especially sure that the de-energizing rails can move freely, and that the de-energizing and braking mechanisms are functioning satisfactorily. The best way to be certain of this is to de-energize and re-energize the Aeromotor.

Strong Frost

For the conditions which prevail especially during a start in a strong frost (temperature lower than +10°C), we refer to the lubrication instructions No. 6770 I-III, which follow.

Strong Winds

The Aeromotor is constructed to tolerate extremely strong winds, but a degree of carefulness is nevertheless advised. The wind can occasionally become so strong that there is a certain risk involved in allowing the Aeromotor to function, particularly if the weather is at the same time unstable. We therefore advise, that in the case of extremely high wind velocities and particularly unstable weather conditions the Aeromotor should be stopped.

Backwind

If the wind is extremely incoherent, it can occasionally strike the backside of the propeller ("backwind") while the propeller is still in motion. Since, as was previously mentioned, this can prove dangerous for the propeller, the propeller should be stopped. In the case of backwind, the start propeller will reverse its rotational direction and, as was previously mentioned, this will cause the de-energizing windlass to de-energize and stop the Aeromotor. As long as the wind is incoherent, the Aeromotor must be kept at rest, and it should not be energized again until the propeller has yawed up into a wind which is stable. When such unstable wind conditions are prevalent, as they often are in connection with thundershowers, it is advised that the Aeromotor be kept under observation.

III. Care and Maintenance /10

The individual mechanical and electrical parts are lubricated as indicated in the lubrication instruction manuals 6770 I-III.

The contactors and the relay's contacts should be checked 2-3 times per week, and kept clean and polished. The single-pole main contactor's contact surfaces should be kept well lubricated with Cramoline paste.

The de-energizing rails should be tested at suitable intervals, for example, after periods of nonoperation. This is done by positioning each sail portion in the vertical, downward-pointing position, and then energizing and de-energizing the Aeromotor with the help of the windlass. The de-energizing rails should then, by its own weight, move freely down to its lowest position (turned in towards the sail), and afterwards up again to the neutral positioning.

The propeller should be maintained by painting, using a paint such as Sadolin and Holmblads synthetic enamel lacquer No. 257.

The mechanical parts at the top of the Aeromotor should be maintained with anti-rust paint, such as A/S Dyrup's aluminum-steel skin.

The voltage limiter's mercury should be cleaned at suitable intervals, whenever it has become impure. This is best done by scraping the surface of the mercury with a piece of stiff paper. The contact pins should be kept clean. The brake cylinder should be filled with transformer oil, which should be changed when it becomes dirty, and the viscosity is thereby increased. A mixture of glycerin and water can be used instead of transformer oil. Water must then be constantly added.

In order to prevent the relays and instruments in the control board in the tower from being subjected to particularly damp air during cold periods (for example, frost weather), we advise that the control panel's insides should be heated. In this case, the rear entrance of the control panel is also closed (with removable insulation), and an electric heater of suitable size is placed inside the control panel. In most cases a large electric lamp will certainly be sufficient for our purposes.

Operating Instructions for Gears (Diagram No. $6770\text{-}I_2$)

The gear is delivered without oil, unless this has expressly been indicated. The oil is added through the hole "A" (see diagram $6770\text{-}I_2$). The gear should always be filled with oil up to the middle of the oil level glass (2), whose height is adjusted so that the wheels dip sufficiently down under the surface of the oil, and that there is oil in the anterior bearing for the propeller axle.

If the oil level in the gear is too low, the result is insufficient lubrication of the teeth and bearings, which results in wear. Overly high oil levels in the gear create unnecessary decreases in the degree of efficiency as a result of the increased oil friction, which will, in addition, warm up the gear and can create the possibility of oil spillage.

We have up until now had excellent results using Gargoyle DTE extra-heavy, from Vacuum Oil Co., but other oil products can also be used, if they are of corresponding quality.

The oil in the gear should be changed after 200 hours operation the first time, and after that, after around 10,000 hours operations. There is a valve with bottom screws for draining the old oil. [1]

Removal of the gear's cope for investigation of the gear's cogwheel and bearings should only be carried out after more detailed deliberation with F.L. Smidth & Co.

N.B. Open flame should not be brought near to an open gear, because of the explosive characteristics of the oil vapors.

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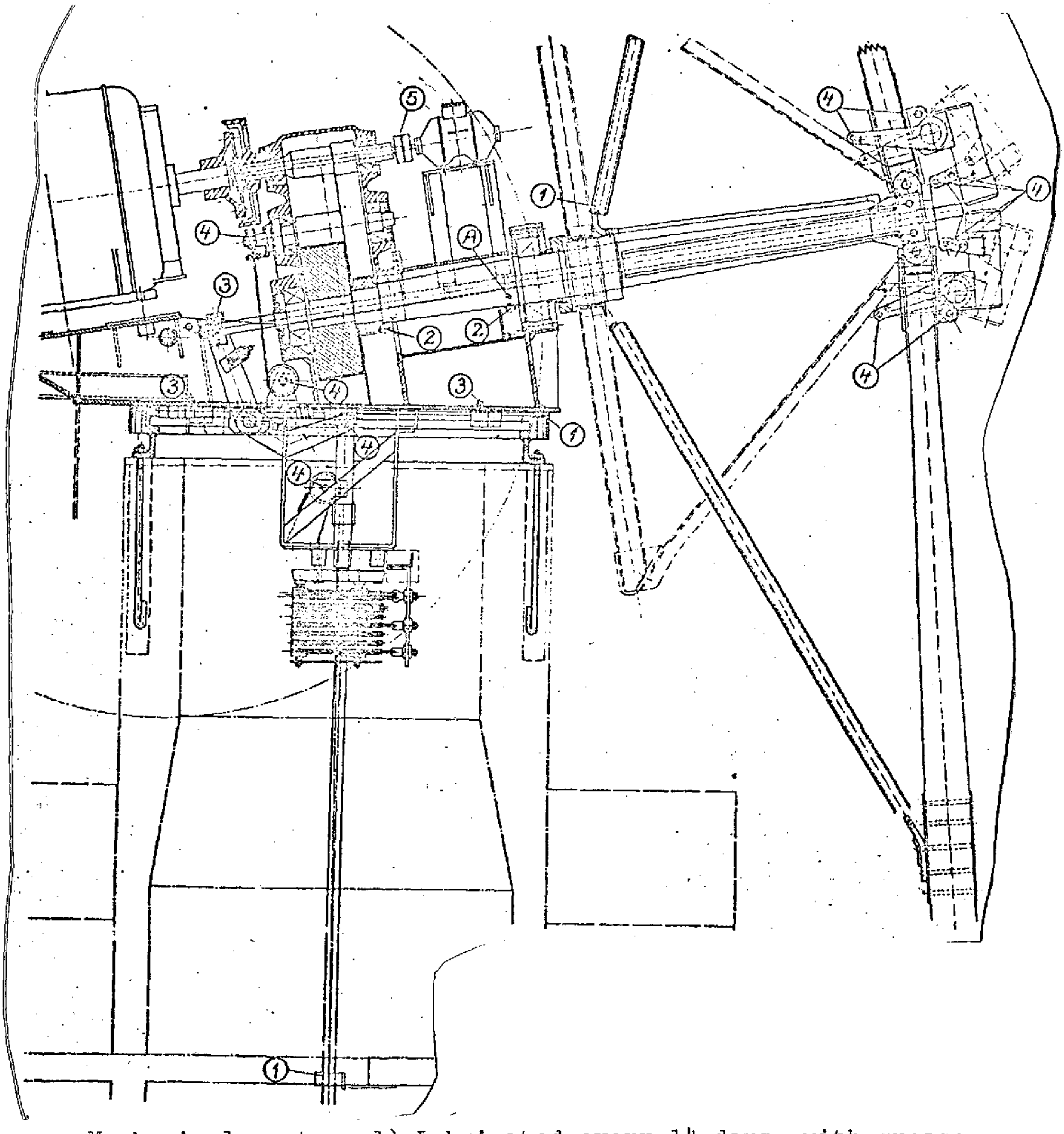
[1] With present oils, it would be advisable to have the oil supplier check the oil two times per year in order to make sure that it is still usable.



Mechanical parts. 1) Lubricated every 14 days, with grease. 2) Checked 2-3 times per week and refilled, when necessary, with oil through "A". 3) Lubricated every eighth day with grease (SKF-ball bearing grease). 4) Lubricated once per month, with oil.

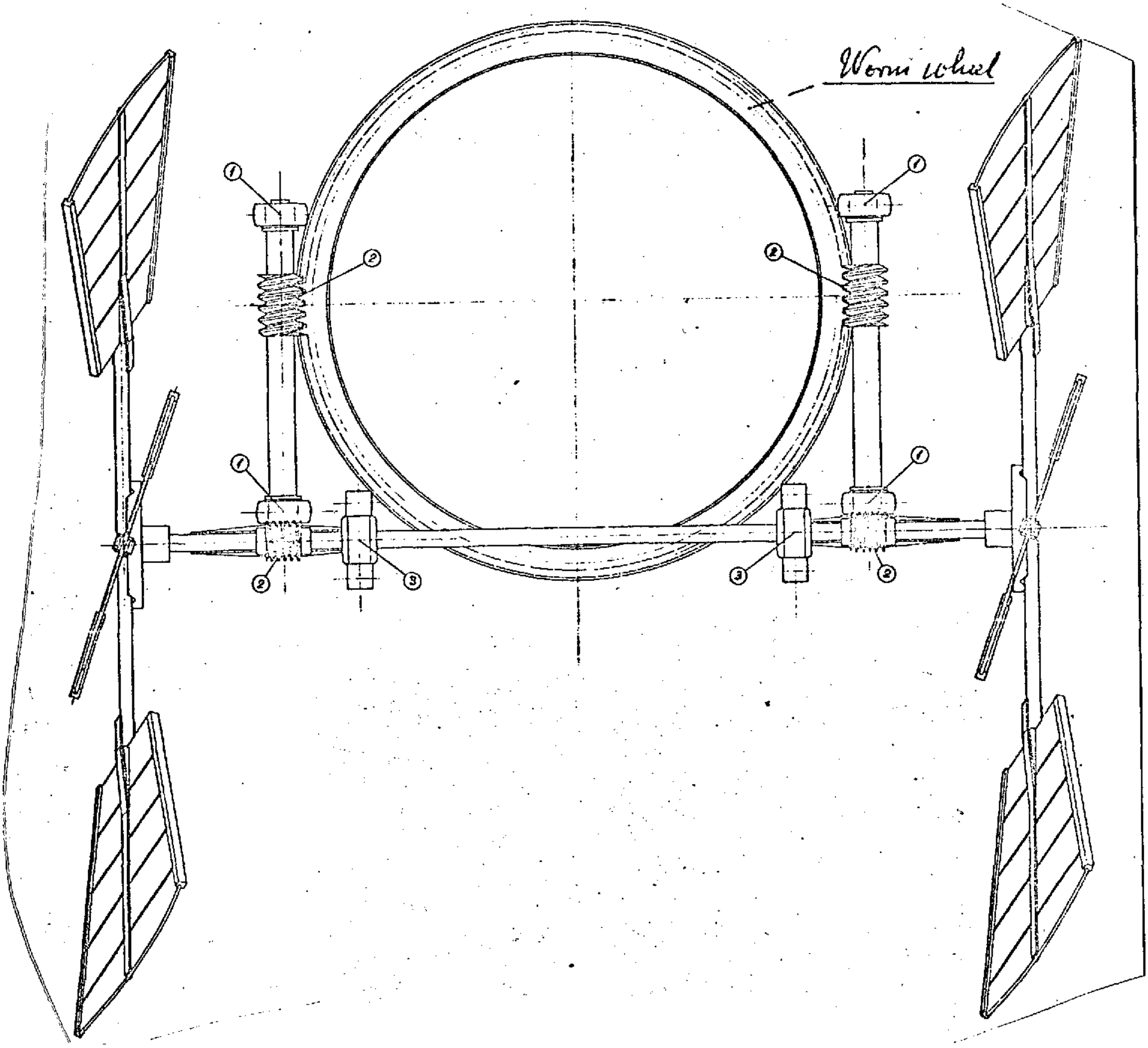
Electrical Parts. The dynamo and the magnetization machinery are equipped with ball bearings. These bearings should be lubricated with ball bearing grease, for example, SKF. One must be sure not [continued on following page]

to press grease into the machinery by exaggerated lubrication. The bearings should be cleaned once per year with gasoline, and lubricated with fresh grease.

<u>Maintenance</u>. 5) Rubber bushings should be shifted, when they are worn so much that the two coupling half portions can be rotated around 2 mm in relation to one another (measured on diameter = [illegible]220 mm).

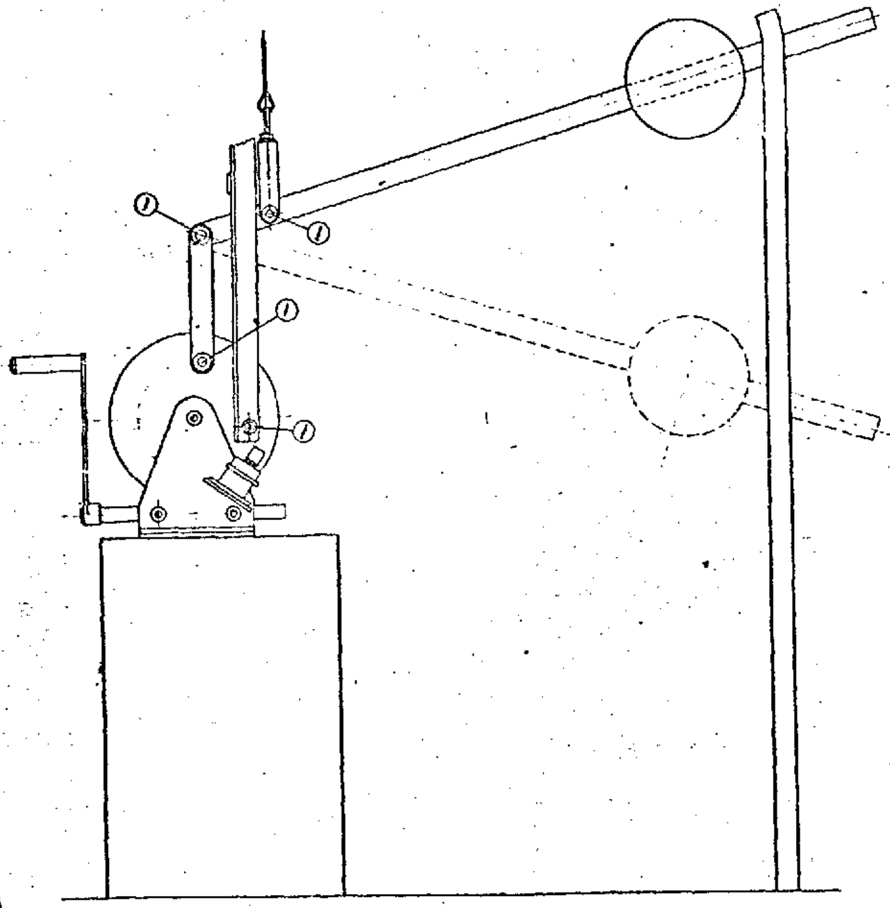
<u>NB.</u> During hard frosts one must be specially cautious when the Aeromotor is started cold. The oil in the gearbox can be so stiff that it must be warmed up before starting, in order to make sure that the gears and bearings are lubricated. For an example, it can be maintained that an oil such as vacuum oil DTE extra-heavy is unsuitable for temperatures below +10°C. The top unit rests and slides upon the worm wheel, which is anchored to the reinforced concrete tower.

Yawing device.



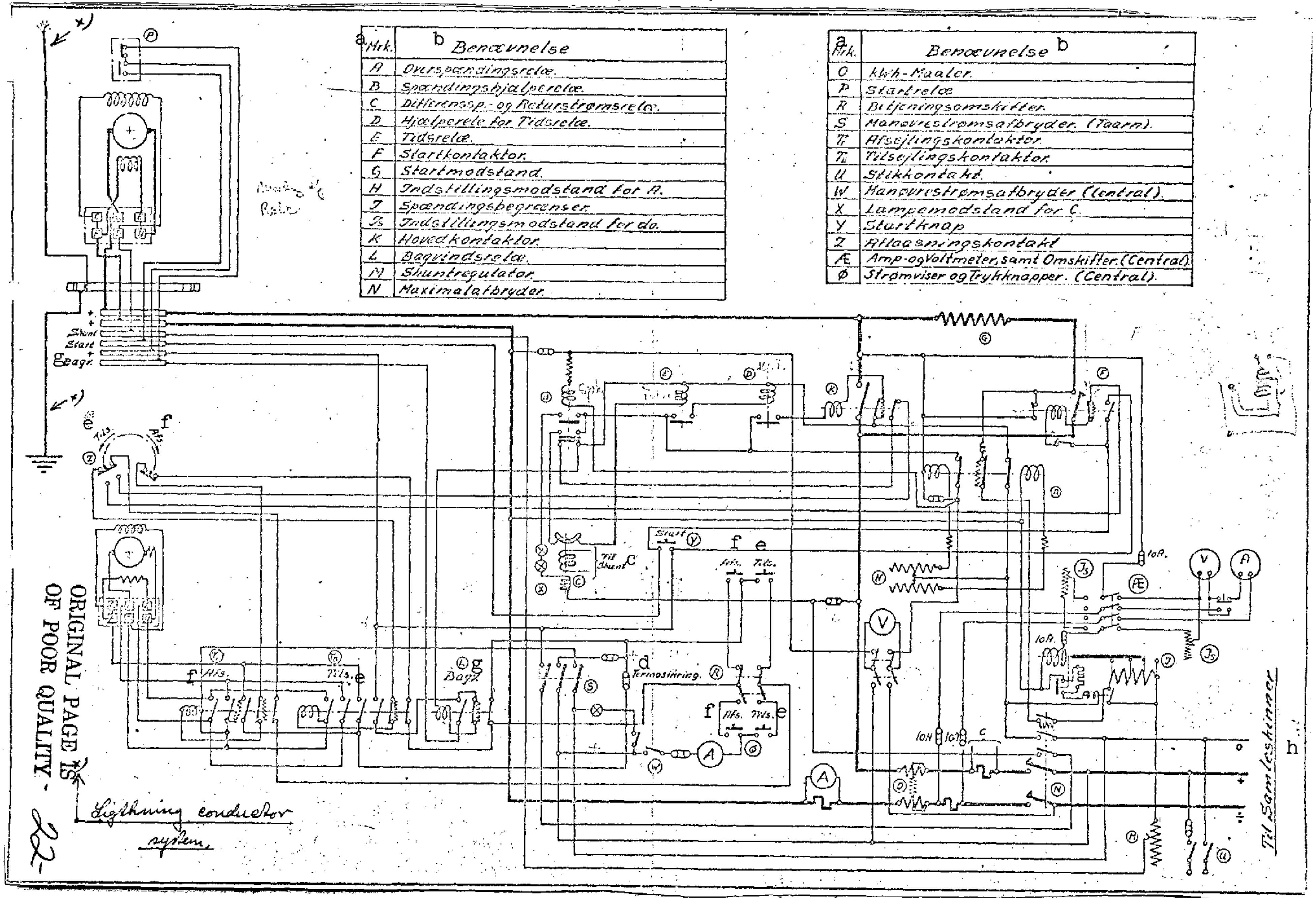
1) Lubricated every eighth day with grease.
2) Lubricated as needed with Gargoyle mobil grease No. 2, or a similar lubricant.
3) Clean and fill with grease once every 3 months.

Hand- and electromotor - operated device for de-energizing and braking of the propeller system.



1) Lubricated once per month with oil. The worm and the worm wheel are lubricated with grease, when necessary. Bearings for the worm and worm wheel are lubricated every eighth day, with grease.

GEDSER COOPERATIVE ELECTRICAL PLANT. PRINCIPAL CURRENT DIAGRAM FOR FLS-AEROMOTOR, 70 kW, 500 V



a Mrk.	b Benævnelse
A	Overspændingsrelæ.
B	Spændingshjælperelæ.
C	Differenssp.- og Returstrømsrelæ.
D	Hjælperele for Tidsrelæ.
E	Tidsrelæ.
F	Startkontaktor.
G	Startmodstand.
H	Indstillingsmodstand for A.
J	Spændingsbegrænser.
Js	Indstillingsmodstand for do.
K	Hovedkontaktor.
L	Bagvindsrelæ.
M	Shuntregulator.
N	Maximalafbryder.

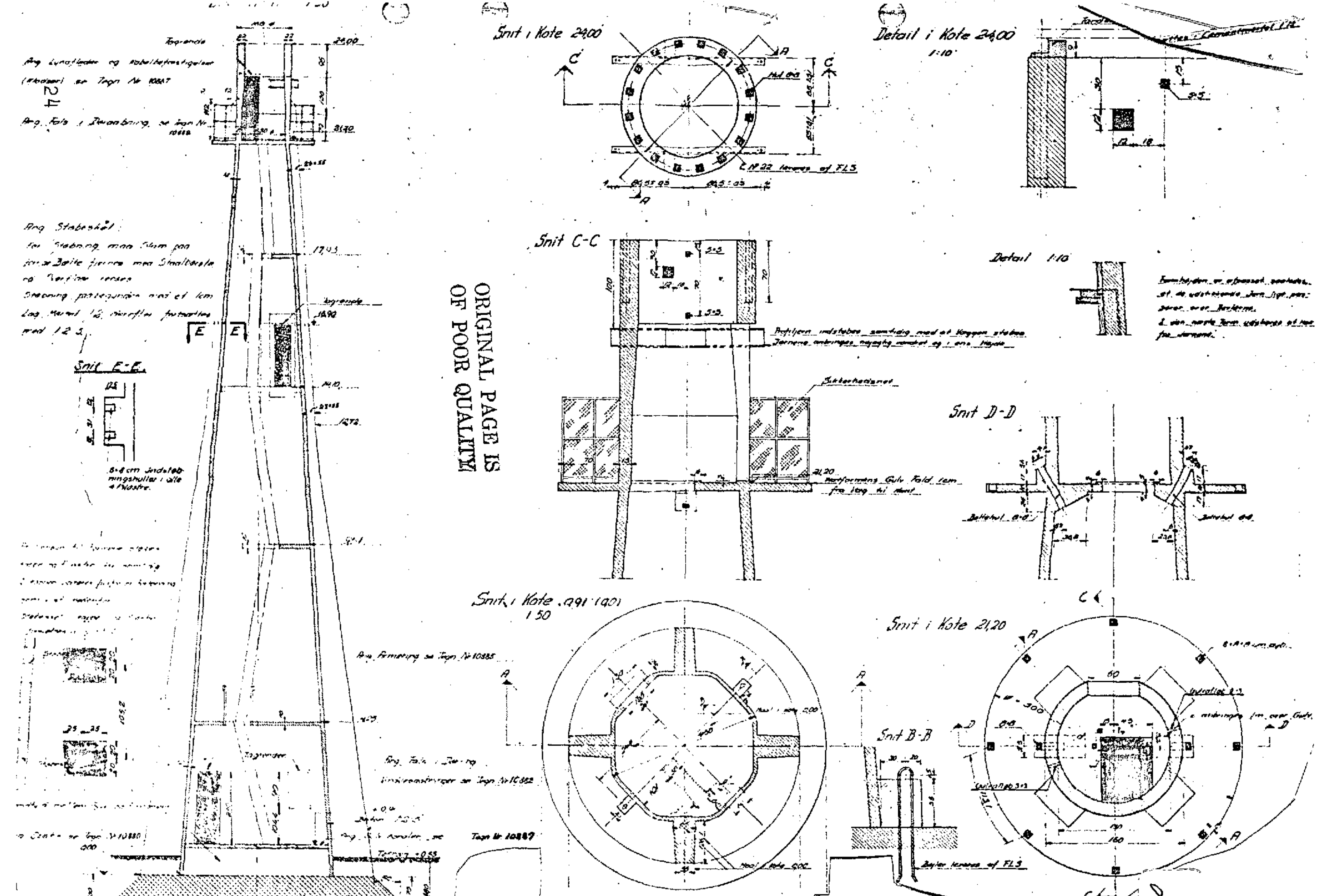
a Mrk.	Benævnelse b
O	kWh-Maaler.
P	Startrelæ
R	Betjeningsomskifter.
S	Manøvrestrømsafbryder. (Taarn).
TI	Afsejlingskontaktor.
TII	Tilsejlingskontaktor.
U	Stikkontakt.
W	Manøvrestrømsafbryder (Central).
X	Lampemodstand for C.
Y	Startknap
Z	Afløsningskontakt
Æ	Amp-og Voltmeter, samt Omskifter. (Central).
Ø	Strømviser og Trykknapper. (Central).

-22-

[Key on following page]

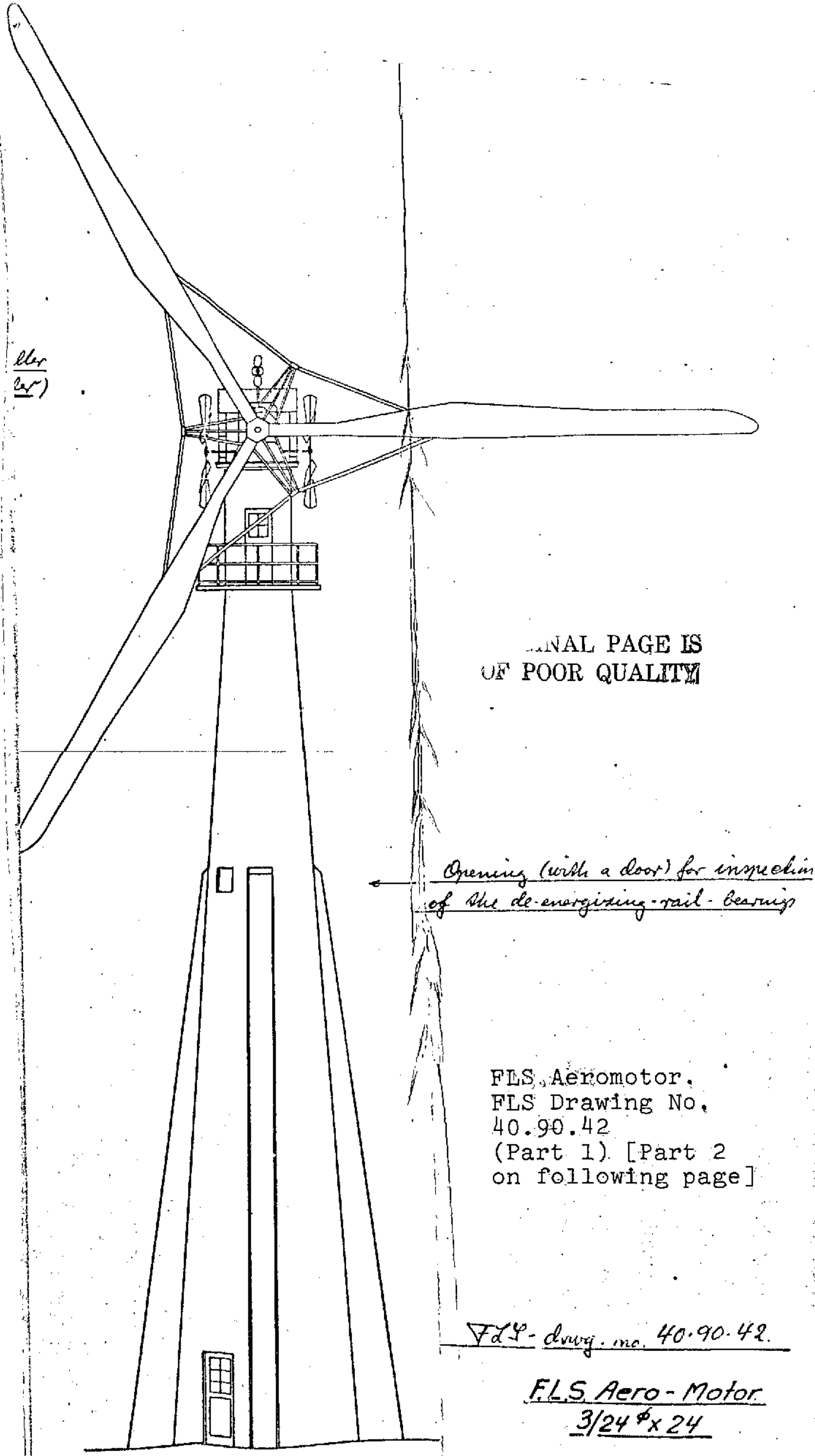
Key to p. 22

a. Mark
b. Name
c. To shunt
d. Thermal fuse
e. On
f. Off
g. Backwind
h. To grid
A. Overvoltage relay
B. Auxiliary voltage relay
C. Difference voltage and return current relay
D. Auxiliary relay for time relay
E. Time relay
F. Start contactor
G. Start resistance
H. Adjustment resistance for A.
J. Voltage limiter
J_s. Adjustment resistance for ditto.
K. Main contactor
L. Backwind relay
M. Shunt regulator
N. Maximum contact breaker
O. kWh-meter
P. Start relay
R. Operation changeover switch
S. Pilot current contact breaker (tower)
T_I. De-energizing contactor
T_{II}. Energizing contactor
U. Electrical outlet
W. Pilot current contact breaker (central)
X. Lamp resistance for C
Y. Starting button
Z. Release contact
Æ. Ammeters and voltmeters, together with changeover switch (central)
Ø. Flow indicator and buttons (central)

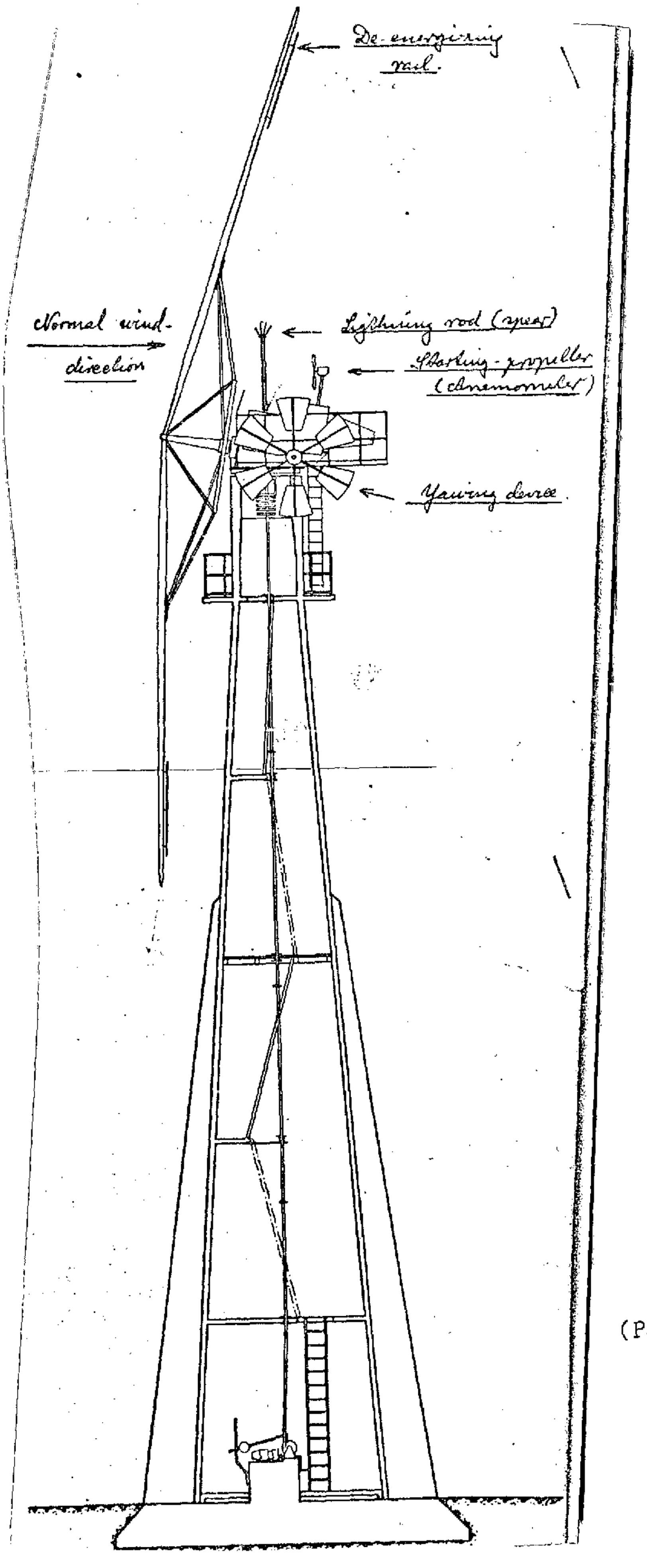


Aeromotor tower. Depth

[Callouts illegible]



FLS Aeromotor.
FLS Drawing No.
40.90.42
(Part 1) [Part 2
on following page]


De-energizing rail.
Normal wind-direction
Lightning rod (spear)
Starting-propeller (Anemometer)
Yawing device.

(Part 2)